We synthesized nanoporous magnetic metalattices by high pressure confined chemical vapor deposition of nickel into silica sphere nanotemplates. Modeling predicts that competition between confinement and the resistance to bending of the magnetic lines of force in these structures should stabilize a series of topologically distinct magnetic states, such as hedgehogs, streams, and spirals. We confirmed that the metalattices behave as truly interconnected, yet confined systems. Such new examples of magnetic materials have often proved useful in applications ranging from data storage to biomedical technologies.